PAPERS

Prehospital intravenous fluid replacement in trauma: an outmoded concept?

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SUMMARY

Details of 235 consecutive trauma patients brought to the Washington Hospital Trauma Center with intravenous infusions in situ were entered into the study. The volume of intravenous fluid administered prior to arrival at hospital and the time over which it was given (the infusion time) was recorded. The initial systolic blood pressure (SBP) on scene and the SBP on arrival at hospital were documented. A mean volume of 383 ml of intravenous fluid was administered over a mean time of 17 min. Of non-trapped patients 98% had infusion times of less than 30 min. Trapped or hypotensive patients were not given significantly more fluid than those who were not trapped or had SBPs of over 100 mm Hg. Because of the uncertain benefits and potential complications of this procedure, intravenous cannulation and fluid replacement may not be appropriate where expected prehospital time is likely to be less than 30 min.

INTRODUCTION

Prehospital intravenous (IV) fluid replacement is a widely performed advanced life support (ALS) procedure in trauma management. The maintenance of blood pressure (BP) is essential for adequate perfusion of vital organs and therefore the case for early fluid replacement is compelling. However, the theoretical benefits of this procedure have been questioned[1]. Scene time may be unnecessarily prolonged by IV line placement[2] and more intravascular volume may be lost during the time it takes to establish access than would be replaced during transport to hospital[3]. Furthermore, IV lines sited prior to arrival at hospital have higher complication rates than those cited in hospital, resulting in over four times the phlebitis rate and over five times the number of patients with unexplained fever[4].

This study was performed to determine whether the volume of IV fluid administered to injured patients before arrival at hospital was sufficient to justify possible delays in transport and the increased risk of complications.

METHODS

The District of Columbia (DC) is an urban area of approximately 69 square miles and has a day time population of one and half million people which reduces to three-quarters of a million at night. It includes five adult and one paediatric level 1 trauma centres and is serviced by 26 ambulances under the auspices of the DC Fire Department (DCFD). Six of these units are manned full time by paramedics (EMT-P) and one part time. The paramedics' training follows the standard US Department of Transportation Paramedic Course outline and results in national registry certification. The training includes intravenous cannulation, insertion of oesophageal obturator airways, defibrillation and the use of a limited number of intravenous drugs.

Prehospital protocols require the insertion of two large bore (14-16G) IV cannulae and the infusion of Ringer's lactate crystalloid solution. The volume infused is titrated against the SBP and the patient transported to the nearest level 1 trauma centre. The decision to insert an IV line is based on an assessment of both the patient's physiological status and the estimated blood loss. The procedure may be carried out at the scene, or *en route* to the hospital, depending on the perceived urgency.

All trauma patients aged 16 or above with intravenous lines inserted in the field by District of Columbia Fire Department (DCFD) paramedics were included in the study. Details of all patients presenting to the Washington Hospital Center Shock Trauma and Resuscitation unit (MedSTAR, Washington DC, USA) over a 5 month period (1 November 1991–30 March 1992) were recorded. The interval between insertion of the intravenous cannula at the scene and the arrival of the patient at MedSTAR (the infusion time) was calculated from the paramedic run sheet and the hospital charts.

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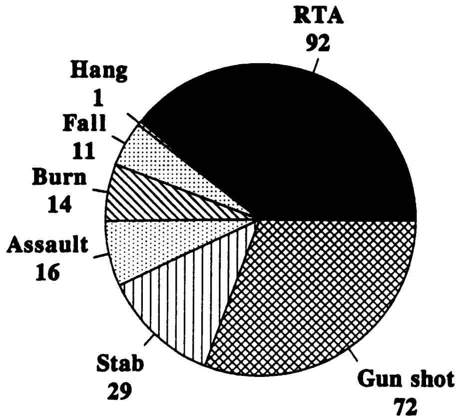

Figure 1 **Mechanism of injury in 235 patients**

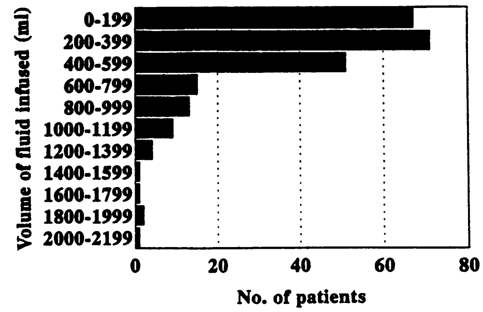

Figure 2 **Prehospital intravenous (IV) times**

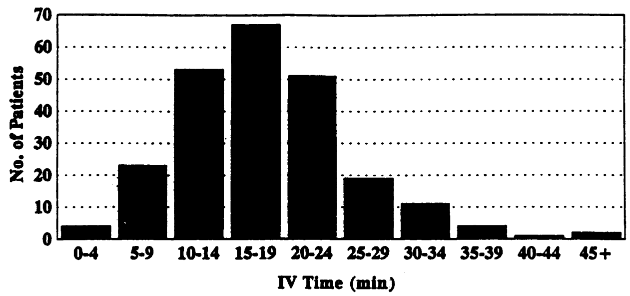

Figure 3 **Prehospital intravenous (IV) fluid volumes**

No formal prehospital trauma scoring system was used and therefore injury severity was not recorded because of the difficulty of its assessment at the scene, often under hostile conditions, such as darkness and in cramped spaces. The initial SBP at the scene, the amount of fluid given during the infusion time and the BP on arrival at MedSTAR was recorded.

RESULTS

A total of 235 patients were entered into the study. The average age of patients was 33 (range 16–84), 79% of whom were male. The mechanism of injury is shown in Figure 1. One hundred and one patients suffered penetrating injuries, of which 72 (72%) were gun shot wounds. Ninety-two of 144 (64%) blunt injuries were caused by road traffic accidents (RTA).

Seventeen patients died in the resuscitation room, of which 12 (71%) were victims of gun shot wounds. Only one of these, a 37-year-old man with a head injury, was not hypotensive at any stage during the prehospital phase. Eleven of those who died had no blood pressure at the scene or on arrival at hospital. Of the six on whom an initial BP was obtained at the scene, but who later died while in the receiving room, the mean IV fluid volume given was 409 ml, similar to the overall mean value of 383 ml. Four of the 16 patients who required prehospital cardiopulmonary resuscitation prior to arrival at hospital, survived to be admitted.

The prehospital infusion times are shown in Figure 2. Of 230 (98%) non-trapped patients, 226 had infusion times of less than 30 min. The mean infusion time for non-trapped patients was 17 min (range 2–37). Five patients required extrication from motor vehicles. They had a mean infusion time of 45 min (range 37–60).

The fluid volumes infused during the infusion time are shown in Figure 3. One hundred and eighty-eight patients (80%) were given less than 600 ml of fluid and 217 (92%) were given less than 1000 ml. The five trapped patients were given a mean fluid volume of 500 ml (range 0–1200).

There were 70 patients (30%) whose SBP was less than 100 mm Hg at some stage during their prehospital management. The mean infusion time in this hypotensive group was 16 minutes (similar to the overall mean). The mean fluid volume administered to this group was 573 ml, compared with a mean volume of 302 ml given to those patients with a SBP of more than 100 mm Hg.

There was a small, but highly significant relationship between volume of IV fluid administered and changes in SBP (r=0.1968, P=0.0002), suggesting that large volumes of IV fluid are likely to cause small rises in SBP.

DISCUSSION

The ultimate aim in the immediate management of critically injured patients is to minimize the time from injury to definitive treatment, at the same time ensuring that the patient has the benefit of timely and appropriate prehospital care. Exactly what defines 'appropriate prehospital care' has been the subject of enthusiastic debate and has been addressed by several authors with differing conclusions[5]. Over the last 20 years, advanced life support (ALS) has become widely taught and rigorously pursued as the gold standard in prehospital care[6,7], but rarely have such important aspects of clinical management been accepted so readily by health care providers, the public and the media alike, with such little scientific and medical evidence to support them[5,8–10].

The problems of data collection are compounded by the difficulties of clinical measurement in the field[11] and by the fact that in the USA, the UK and many other countries, a majority of prehospital care providers, while trained to varying degrees, are not medically qualified. In many cases, ALS providers continue to function without adequate medical direction allowing non-physicians to make medical decisions[8].

While there is no dispute as to the value of good airway management, cervical spine stabilization, external haemorrhage control and fracture stabilization[6], many authors have found the administration of prehospital intravenous fluids to trauma patients has no influence on mortality[1,2,12,13]. In a preliminary study by Martin *et al.*[14] involving 300 patients with penetrating wounds to the trunk, there was no significant difference in mortality between those who received preoperative IV fluids and those who did not. Indeed, there was evidence of a decreased incidence of adult respiratory distress syndrome (ARDS) and coagulopathies in those patients who did not receive IV fluids prior to surgery.

The benefit of IV fluid replacement in bleeding patients immediately post injury was questioned as early as the First World War when Cannon *et al.*[15] suggested that blood loss in wounded soldiers was minimized because the BP was too low to overcome clot formation. In 1968, Wangensteen *et al.*[16] reported that the main determinants of blood loss from a lacerated artery are the area of laceration and the BP. He concluded that raising BP by IV infusion may cause increased bleeding in pateints suffering from haemorrhagic shock. Haemorrhage may be further exacerbated by the dilution of clotting factors caused by the administration of high volumes of crystalloid solution. These findings were supported by Krautz *et al.*[17] in a study of rats with induced uncontrolled haemorrhagic shock. Those left untreated were more haemodynamically stable, had higher mean arterial pressures, higher haematocrits, less total blood loss and suffered the same mortality as those treated with IV saline volume replacement.

In a computer simulated study by Lewis[18] of patients with major haemorrhage from trauma, it was found that prehospital fluids were unlikely to be of benefit if: (a) the rate of haemorrhage was less than 25 ml/min or greater than 100 ml/min; (b) the prehospital time was less than 30 min; and (c) the infusion rate was less than the bleeding rate. In the present study, the average infusion time was 17 min during which time 302 ml fluid were infused in normotensive (SBP $<$ 100 mm Hg) patients, equivalent to a flow rate of 18 ml/min. In hypotensive patients (SBP$<$100 mm Hg) 581 ml of fluid were infused, giving a mean flow rate of only 34 ml/min despite the use of pressure bags. In the adult, at least 30–40% of blood volume (approximately 1500–2000 ml of blood) must be lost consistently to cause a drop in SBP. Furthermore, three times the amount of blood loss should be given if crystalloid is being used as replacement fluid[19]. If the findings of Lewis' study are applied to these results, the volumes administered would be inadequate to replace probable losses, thereby offering little clinical benefit.

Intravenous cannulation may cause a delay in transport[20–22]. In a study of 52 consecutive hypotensive trauma patients, Smith *et al.*[2] found that transport time to hospital was less than IV establishment time in all cases, and that the fluid volumes infused were too small to have had any influence on final outcomes. Failure to place IV lines occurred in up to 27% of the more severely injured and further increased the time to definitive treatment. These findings are in keeping with those of this study.

If IV cannulation is performed while *en route* to hospital, there is no concurrent delay[23–25] and there is the advantage of intravenous access available for immediate administration of drugs and fluid on arrival at hospital. On the other hand, IV placement in a moving ambulance may raise the risk of infection and/or traumatic insertion, rendering subsequent venepuncture more difficult[4]. Prompt transport of unstable patients should not be delayed solely to obtain IV access[26], although IV cannulation performed on scene may be appropriate in trapped patients for whom the length of time they will remain on scene is unknown.

This study analyses results from a small urban area well serviced by trauma centres and paramedic units. Therefore 98% of severely injured patients have infusions running for less than 30 min. As a result, even hypotensive patients were given a mean of less than 600 ml of intravenous fluid, which is unlikely to replace probable losses. The use of wider bore, shorter cannulae would certainly increase the volumes administered and therefore raise the SBP. Further studies should be carried out to assess this widely performed ALS procedure by comparing outcome in patients who have had the benefit of no fluid replacement with those to whom large volumes of intravenous fluids had been given.

CONCLUSION

The uncertain benefits and possible hazards of prehospital IV cannulation and fluid replacement as well as the inherent delay it may cause mean that IV cannulation and attempted volume replacement may not be appropriate in the management of trauma where expected prehospital time is less than 30 min.

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